Concrete Ships Offer Added Power Against U-Boats

Hundreds Can Be Built Without Drawing on Men, Material or the Engines Needed for Regular Programme

Risk Involved in Going Ahead Without Experiment Beyond Ship Board's Power—Delay May Be Fatal

By Theodore M. Knappen

IT TAKES an idea a long time to gain momentum.

A Frenchman built a concrete rowboat in 1849. It is still in use.

Hundreds of concrete vessels of various kinds have been built in recent years. But the engineering and marine worlds have not yet made up their minds whether concrete ships are feasible.

Late in December the United States Shipping Board established a department of concrete ship construction and began to feel its way. It is still feeling. The inertia of the conservatism to be overcome is tremendous. The engineers are calculating and conjecturing, and provisional contracts have actually been let to three companies, the general provision being that if the first ship is successful the companies will be authorized to proceed with considerable numbers.

Outcome Depends On More Shipping

But the building of these first experimental ships will take a long time, and when they are done and proved and accepted it will take a long time thereafter to get ready for large scale and rapid production.

Then, when the word is given to go ahead, the war may be lost.

War is a gamble. We—we Americans alone—are gambling at the rate of about twenty billions of dollars a year that we are going to lick the Germans. The outcome of the gamble depends more on shipping than any other material factor. The food, munitions, supplies, airplanes, artillery and soldiers that are to win the war, if it is to be won, are on the American side of the Atlantic. Only ships in abundance and in a hurry will get them across before it be too late to fight or win the war in Europe. After that it will be fought on the high seas and on our own land. Therefore the need of ships is supreme.

At present, ordinary causes and German submarines and mines are sinking ships faster than they are building. The most carefully compiled figures on this subject show that since the beginning of the war the Allied and neutral losses from German attack have been more than 10,300,000 tons. In the same period the losses from ordinary causes have been 1,600,000 tons. During the same time the world, outside of the Teutonic countries, has built 6,600,000 tons. It has expropriated 875,000 tons of Teutonic shipping. Its net loss, therefore, is not far from 4,500,000 tons. Even with all the shipbuilding that is now in progress the submarines are getting away with somewhat more than is being built.

U. S. Entrance Requires 5,000,000 Tons

Assume that the destruction and construction are even, and you still have that deficit of 4,500,000 tons in the pre-war supply of shipping, and the additional fact that the entrance of America into the war has created an extra demand for at least 5,000,000 tons. Remember, too, that owing to the deterioration of vessels from infrequency of repairs, the slowness of repairing and the retardation of speed and general lowering of efficiency due to the conditions imposed by the submarine danger, ships are doing less service than in peace times. Considering all the factors, it is not too much to say that the world ought to have 18,000,000 tons of new ships this year to provide that abundance of transportation that will insure the defeat of Germany.

Recent developments show that war-weary England cannot be relied upon for more than one-ninth of that figure. Practically all the rest must come from the United States.

Will Build Four Million Tons This Year

Our present 1918 programme calls for 6,000,000 tons dead weight. We built last year about 1,600,000 tons dead weight. The present prospect is that we shall build between 3,000,000 and 4,000,000 tons this year, with still a slight hope of the 6,000,000. But the loss figures are given in registered tonnage. Even if we complete our 6,000,000 we shall only make a 4,000,000 inroad into the 18,000,000, on a gross tonnage basis.

The absolute limit of wood and steel tonnage production is being attained.

Remains only concrete as a hope for still more ships.

There is no immediate hope in concrete except by taking a great gamble.

The hazard will consist in starting NOW to build an immense number of ships as an admittedly audacious venture instead of waiting weary months for four or five trial ships.

HOW THE CONCRETE SHIP IS BUILT

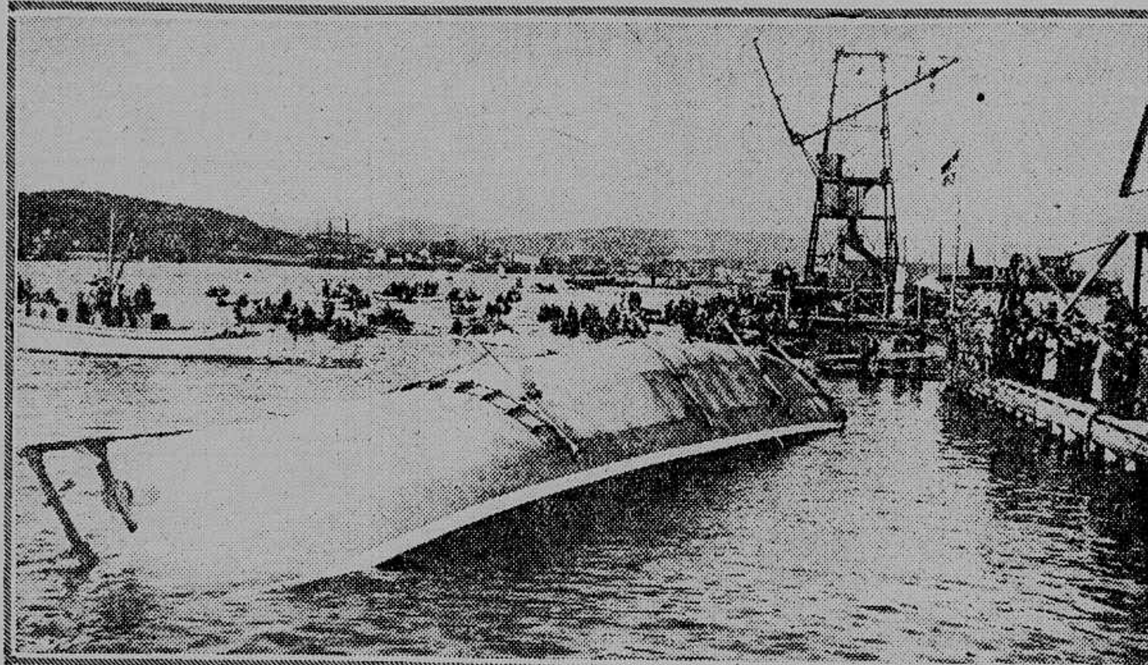


Photo Kadel & Herbert

A concrete ship righting itself in the water after being launched

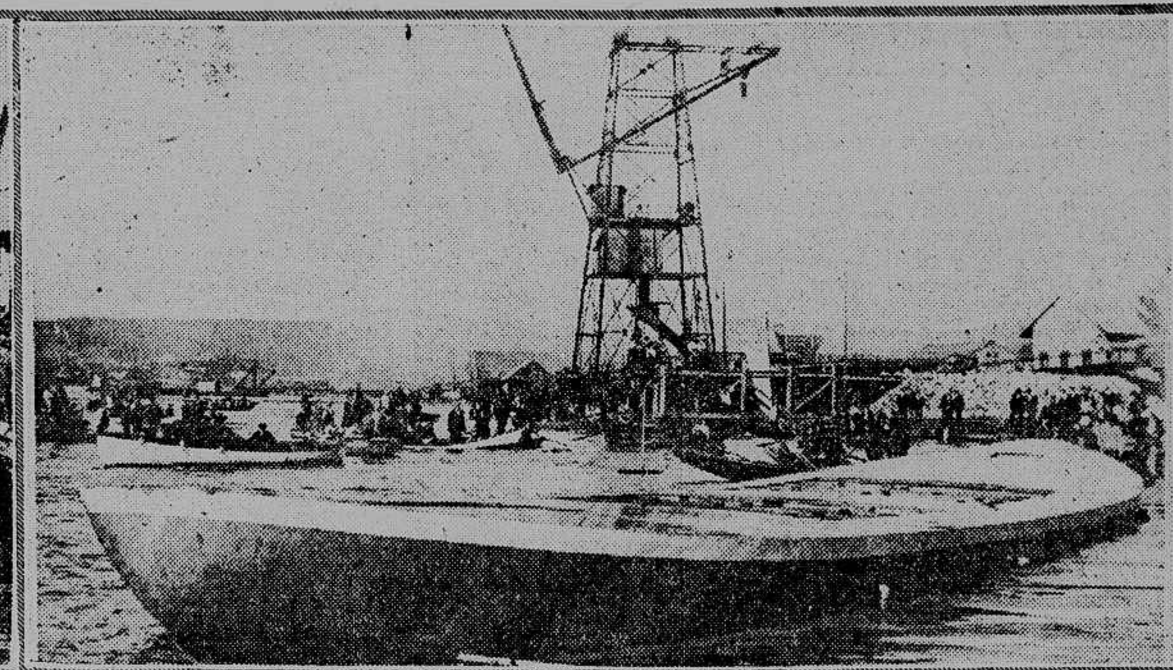
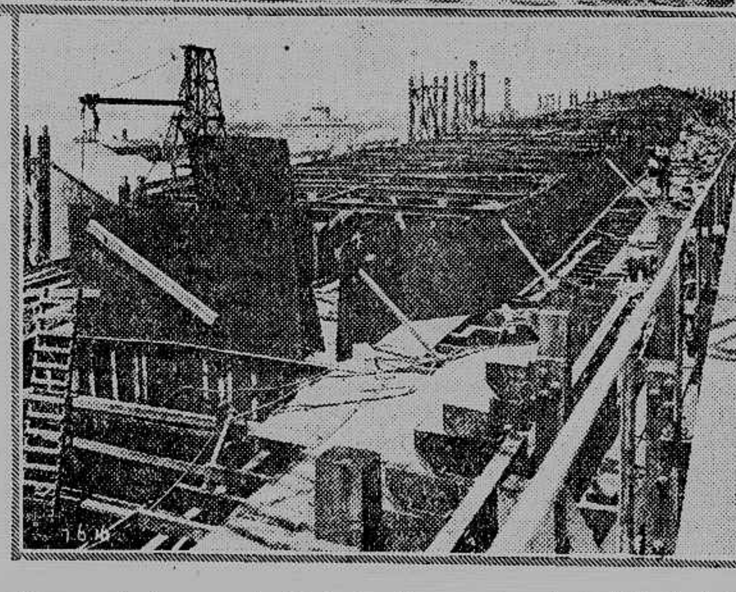
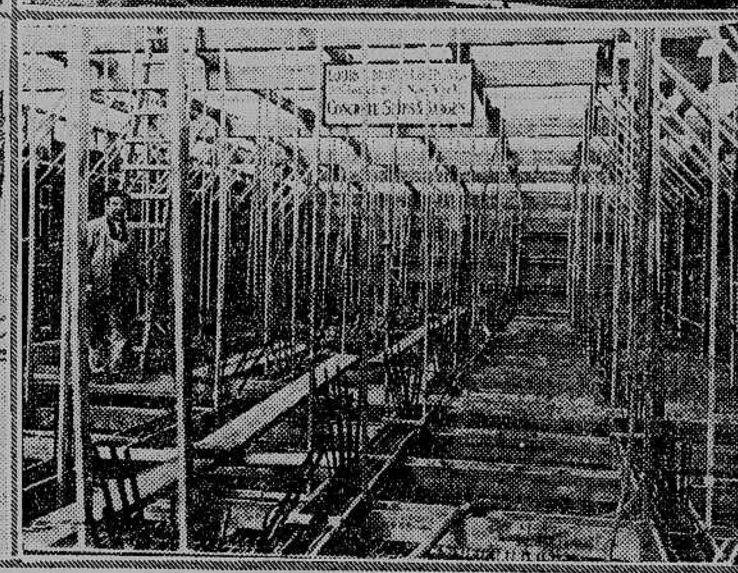


Photo Kadel & Herbert

A concrete ship after it has righted itself, but before the water is



The framework of a concrete ship before the concrete out of which the hull is moulded is poured in.



Interior of a concrete boat under construction, showing the reinforcing steel work before the concrete is poured in.

It is conceivable that this country can build 500 five-thousand ton concrete ships in about twice the time that a few pioneers will require. They would cost, exclusive of machinery and fittings, about $400,000,000—say about $500,000,000 all told.

The Shipping Board, mindful of the relative failure of the wooden ship programme; mindful of Congress; mindful of public opinion and technical conservatism, dare not take the responsibility of this magnificent gamble—a win-the-war gamble. It has taken the initiative. It has discovered that the chances strongly favor the complete success of the concrete ships. The country and Congress must take the grand responsibility for a large "ante" on this $500,000,000 if they want to feel that they have done everything within their power to bridge the Atlantic, to answer the appeal of General Foch:

Need to Hurry Is Imperative

"Hurry! Hurry! Hurry! Do not waste even half a minute!"

What is even half a billion if it is to determine the issue of the war or whether the issue is to be fought out in America instead of Europe? Hurry, or there may be no place for us to land troops in Europe! It may be all German!

Inquiries at the offices of the Emergency Fleet Corporation give the gratifying information that even with all the strain that has been put on them the boiler and engine manufacturers of America can "come through" this year with power for the propulsion of the five hundred concrete ships.

Cement men and workers in concrete say these ships can be built. Next year, if there still be time for shipbuilding, we might turn out two thousand concrete ships. If these were of 5,000 tons each, instead of the 3,500 tons the Fleet Corporation now favors for the first ventures, there would be in two years 12,500,000 tons of concrete ships alone.

All of this can be done by utilizing labor that is but little used in building steel and wooden ships by using only a limited amount of the kind of material used in such ships and by calling on a great industry that has not yet been strained by war demands—the cement industry. Finally, it would not draw skilled men from other war work. The present supply of workers skilled in concrete and an army of unskilled men would do the job.

If a $50,000,000 gamble or a $250,000,000 or a $500,000,000 gamble is too quixotic, a much less expensive chance can be taken which will still save many months. It is calculated that owing to the small amount of equipment required in a yard designed to build concrete ships the need of less storage and warehouse space, etc., such yards can be built and completely equipped for $20,000 a way. Thus a ten-way yard would cost $200,000.

Yards can be built with a large capacity while the experimental ships are building. If the latter are satisfactory many months' time will be saved thereby. Yards with one hundred ways, say, could be built for only $2,000,000—plus the cost of the sites. As soon as the experiments are concluded work could then be started on a hundred ships, and from these ways 200 ships could be launched within twelve months.

While there seems to be no reason why, after yards have had some experience, concrete ships cannot be launched within thirty days, it will probably take about six months to construct the experimental ships. Then it will take three to six months more to build large yards for quantity production. By starting now the yards will be completed before the first ships. In the event of concrete construction for large boats being ascertained to be a failure the yards would be available for adaptation to the building of wood or steel ships. While the yards were building other preliminary arrangements, such as planning for supplies of materials, laborers, transportation, housing, etc., could be made. Probably $10,000,000 at the outside would have everything ready for 100 ways to begin on ships.

Again, long before the yards would be done, or the experimental ships that are now being started under contract with the Shipping Board, the 4,500-ton concrete ship that the San Francisco Shipbuilding Company expects to launch at Redwood City, San Francisco Bay, next Thursday, will have been proved a success or a failure. In the former event the proposed concrete shipyards could be rushed to completion, contracts could be let for hundreds of boats of the new type and but little time would be lost.

So far as engineers can foresee, there is nothing to preclude the success of the concrete ship. The situation is that, while hundreds of concrete barges and other small vessels have been successful, no large ship of concrete has ever been completed and tried out. The technical side of concrete ship construction has been worked out in the greatest detail. In fact, it was not until that had been done that the Shipping Board created a division of concrete construction, began to draft plans for a standard 3,500-ton boat, and even committed itself to provisional contracts, in which it stands a part of the expense of the experimental boats in the event of their failure. Except for the element of size, there is already a large amount of empirical data relating to concrete vessels.

After the Frenchman, Lambot, built his rowboat nobody attempted to apply concrete to navigation until 1887, when eleven-ton concrete barges, and, a little later, fifty-five-ton barges were built for canals in Holland. In 1897 a concrete pontoon was built in Italy. In the same country successful barges of 150 tons were built in 1905. In 1910 a concrete barge that has been entirely satisfactory was built for the Welland Canal in Canada. In the same year a 525-ton scow was built in San Francisco and large scows at Panama. In the same year, also, and later, concrete barges were built for port use at Bahia, Brazil. In 1911 they began to build scows for use on Chesapeake Bay. In the following year a 500-ton scow was put into service at Baltimore. In 1911 a concrete sailboat was built at Dresden, Germany. A 100-ton concrete scow was put in service on the Manchester Ship Canal, in England, in 1912. A 500-ton scow was built at Fairfield, Md., in 1913. Numerous lighters, scows and barges were completed in the next five years. A 400-ton motor boat, using Diesel engines, was completed by Foughner's Steel Concrete Shipbuilding Company of Moss, Norway, last year, and proved successful after severe ocean trials.

The same company has completed, or is about to complete, a 3,000-ton oceangoing ship, and is now offering to contract for 3,000 and 4,000-ton ships. Concrete barges are building in France by the hundreds. Concrete yachts have been built in Massachusetts and at Chicago. British naval architects are reported to be offering to build and guarantee concrete ships. A 200-ton motor lighter was put into service by the Porsgrund Cement Casting Works, Porsgrund, Norway, last summer, and a nine-foot model of this boat was turned over to the United States Bureau of Standards for study—the study that led the Emergency Fleet Corporation to create its concrete shipbuilding division. A 300-ton ship is almost ready at Montreal for lake service. Finally, there are the 700-ton barges built and building by the Louis L. Brown Company, Inc., of New York, and the 4,500-ton ship on San Francisco Bay mentioned above.

Test Still Needed On Ocean Conditions

From an examination of all the data relating to the concrete vessels in service, it appears that practice has long since demonstrated their suitability for protected waters in almost any size and for ocean-going in small size. There remains only the testing of large self-propelled ships under ocean-going conditions. The San Francisco ship will soon supply the missing link.

The Shipping Board is in no way responsible for the last named ship, but is prepared to reimburse the owners for her injury or destruction in submitting to such tests as it may suggest, and has watched her progress with the greatest interest. It has given provisional contracts to the Liberty Shipbuilding Company, of Boston; the Foughner American Steel Concrete Shipbuilding Company, of New York, and the Ferro-Concrete Shipbuilding Company, of New York. The contract with the first named company is for a trial boat of 3,500 tons, the risk being taken by the company and the government on a 50-50 basis. If this first boat be successful, the company is to have a contract for forty-nine more, which will likely be of 7,500 tons. The experimental ship is building at Brunswick, Ga. The San Francisco Shipbuilding Company, which is completing the above mentioned 4,500-ton vessel on its own account, is to be awarded a contract for a 7,500-ton boat. The Foughner company has a provisional contract with Norwegian shipping interests for six 8,000-ton boats. The Ferro-Concrete Company is building a 3,500-ton boat at Redondo Beach, near Los Angeles. Each company has a method of its own, but all use ferro-concrete.

The concrete boat, assuming that it is a success, has some disadvantages and some advantages as compared with steel ships. The chief disadvantage is that, on account of the thickness of its walls, a ship of a given size will have less cargo space than a like one of steel. On the other hand, it will not be so heavy. It will have a smoother surface, and will therefore not offer so much resistance to the water.

Can Be Built Quicker Than Steel Boats

It is rat-proof, rot-proof, rust-proof and inimical to barnacles and other marine growths. It does not require frequent and expensive painting and is easily and cheaply repaired.

Concrete ships can be built in quantities more rapidly than steel. Their cost is probably not more than two-thirds of steel, and may be very much less. It is even less than that of wooden ships. They will probably last thirty-five years, as against twenty-five years for a steel ship. As such a ship is practically a monolith, it will not be as leaky as a steel ship, and injuries will be localized. As a concrete ship consists principally of cement, sand and gravel, their chief building material is usually available near by. The reinforcing steel rods, meshes, etc., do not draw on the kind of steel required for steel ships. Such wood as is needed will not interfere with the progress of the wooden ships. The workmen are simply the same class of labor as is used in building edifices of concrete. Very little highly skilled labor is required. Hence the concrete ship is practically drawn from new sources of labor and material. It can be built in quantities without interfering with the present wood and steel programmes.

The yards for the building of these two classes of boats are now so numerous that to start any more has the effect of delaying the others, for there is a limit to the quantity of labor and material for them. Assuming that we are now planning for the uttermost limit of steel and wood capacity, which is about the fact, we have still in concrete ships an entirely new and almost unlimited shipbuilding capacity. The United States has an immense cement producing capacity, and, owing to the suspension of building to a large extent during the war, all of the cement needed for ships can be supplied without interfering with other war business.

Machinery for 500 Is Already Assured

Taking it for granted that concrete ships are successful, the United States could, by starting in at once, probably build 500 of them within twelve months, and possibly several hundred within the current calendar year. Machinery for 400 or 500 3,500-ton boats is assured. If the average size were to be 5,000 tons, not so many ships could be equipped with power this year, but the total tonnage would be as great.

By beginning now just as if we were as sure of the concrete ship as we are of the steel ship we stand to add several millions of tons to our shipping resources this year, and by next year we shall be in shape to build them in such numbers that, in conjunction with the ten or twelve million steel tonnage we may then realize, the submarine's greatest possible inroads would be a comparative trifle.

Before we knew whether we had picked a winner or not, we might invest many millions of dollars. They might be lost. We might have to scrap half-built plants. But if we should pick a winner we would have saved not only those half-minutes that General Foch does not disdain to mention, but half a year—and, perhaps, the world.

What Experts Say of the Possibilities of Concrete Ships

Scotch Engineer Says Small Boats Give Good Results

By Bernard J. Ives

(In a recent issue of The Glasgow Herald. Mr. Ives is a leading marine engineer of Scotland.)

The economic conditions brought about by the war have caused attention to be drawn to the possibilities of ferro concrete for ship construction. It is therefore not surprising that developments were made early in the war in Scandinavia, where a comparatively small amount of steel is produced. The firm of Messrs. Fougner, of Moss, were early in the field, and they have constructed many barges up to 250 tons dead weight, which have been in service for over a year. At the moment several vessels of 1,000 tons are in the course of construction in Norway. One motor vessel, the Namsenfjords, fitted with a Bolinder engine of 80 b. h. p. and capable of carrying 200 tons, has been tried under seagoing conditions, with, it is understood, satisfactory results. The speed developed is about seven and a half knots.

As the ferro concrete is only in its experimental stage, and as practically no experience has been obtained so far from actual seagoing conditions, a wise precaution at the present time is to eliminate any doubtful factors, and the steel therefore should be of the quality used in ordinary shipbuilding work.

Upkeep of hull due to wear is considerably less, while the life of ferro concrete ships is likely to be much longer than that of steel ships, the concrete not reaching its maximum strength until many months after launching.

Then it is possible to build the ships very quickly once an establishment is arranged and equipped, and fire-resisting and insulation properties are good, while insect life (a constant source of worry in wooden vessels) is eliminated.

The great disadvantage is the large additional light weight of the vessel, in comparison with that of a steel ship of the same size.

It is in vessels of moderate size, say up to a maximum of 250 feet in length and 2,000 tons dead weight, that ferro concrete will be found to be a suitable material, the reason for this being that in large steel vessels the amount of steel used in the construction has been reduced to the minimum which recognized authorities consider consistent with a safe working stress on the material.

There is, therefore, little probability that in vessels much above the size indicated ferro concrete will be employed.

Naval Architect Approves Building 9,000-Ton Vessels

By Morgan Barney,

Naval architect, who has designed a 9,000-ton concrete ship.

When my attention was first called to the possibility of building concrete ships, over a year ago, I made a few calculations, based on a limited knowledge of concrete structures, and promptly dismissed the plan. Later the question came up again in a way that could not be evaded, and with the assistance and coöperation of some very able American engineers and builders who were specialists in concrete and steel construction we began work on the design of a 9,000-ton steel and concrete ship suitable for transatlantic service.

The calculations of stresses and strains were carried out with the greatest care, and at each step they were compared with those of a steel ship of similar dimensions, until in the end each member of our ship was as well able to bear its proportionate load as a steel vessel, and the concrete shell itself was given a local strength equal to twice that of a shell plating which it replaced. The questions of expansion due to temperature changes, flexibility, watertightness, protection of the reinforcing steel, the proportions of the mixture and many other technical details and methods of construction were carefully studied. These plans have now received the final approval of the Engineering Fleet Corporation.

I have also prepared plans for ferro-concrete barges, suitable for the New York State Barge Canal and other inland waterways, but the problems presented in this type of vessel are relatively simple.

There appears to be a loss of from 5 to 10 per cent in cargo carrying capacity, but this is offset by other advantages—perhaps the most convincing being that the war has created a situation where we must have concrete ships or nothing.

The available steel and wood shipbuilding capacity of this country has been reached and passed, but the resources that can be turned to the building of concrete ships are as yet untouched.

The cement, sand and crushed stone are unlimited. The steel required is of a character that is not used in steel ships, and the same is true of labor. Special shipbuilding machinery is not required.

Statistics show that in our cities new building construction has fallen to about 40 per cent of normal, and this situation can be taken advantage of by building concrete ships of ocean-going tonnage, oil tank steamers and also barges for our unused inland waterways to carry bulk freight that our railroads are unsuccessfully attempting to handle with their inadequate equipment and limited terminals.

The demand for ships is so great that it cannot be met under existing conditions, but the use of concrete will give us many more ships and a greatly increased rate of production without in any way interfering with the shipbuilding programme already under way. To be effective this work must be undertaken at once.

Shipbuilder Says No Limit Can Be Put on Dimensions

By Nic. K. Tongner

(Foremost builder of concrete ships, who has come to America to build them here.)

Concrete ships can be built with materials and labor that at the present time are not required in other shipbuilding. In other words, by building concrete ships we add tonnage without depriving the steel shipbuilding yards of their skilled mechanics, without depriving them of the structural steel manufactured in the shops for building steel ships, without depriving the wood ship builders of the heavy lumber required for building wood ships, without making use of the skilled ship carpenters necessary for the wood ship construction.

Concrete ships are built with materials that otherwise would practically not be used for war work at all.

The principal materials needed are Portland cement, sand, gravel and steel reinforcement of the ordinary type used for building purposes. Common, unskilled labor can be employed for the greater part of the construction.

All things being equal, concrete ships can be constructed in about half the time that is required for building steel or wooden ships.

It is my personal opinion from the experience I have gained through building some twenty-odd vessels of concrete in Norway of different sizes and types that seagoing concrete ships can be built successfully of sizes ranging between 3,000 and 4,000 tons, which is large enough for transporting munitions, supplies, troops, etc., to France.

No one at the present time can state with any certainty what limitations in size there may be for concrete ships. This new type of shipbuilding must naturally be developed gradually, just like the steel ships have been, and it would be folly for any one to assert at present that concrete ships cannot be built as large as ships of other materials.

Difficulties Will Be Defeated by Modern Science

By Professor George Owen

(Naval Architecture Department, Massachusetts Institute of Technology.)

BOSTON, Mass., March 9.—The study of concrete ships is one of the most complicated problems that have come before the engineer. Practically everything that we have learned about shipbuilding has come from experience. In the construction of steel ships we have tried certain lengths and widths and found them successful, and then have added length and width in making larger craft. In bridge construction the engineer knows the exact weight the structure will stand and what weight it will have to stand to fulfil requirements. The engineer works with tried and proven problems.

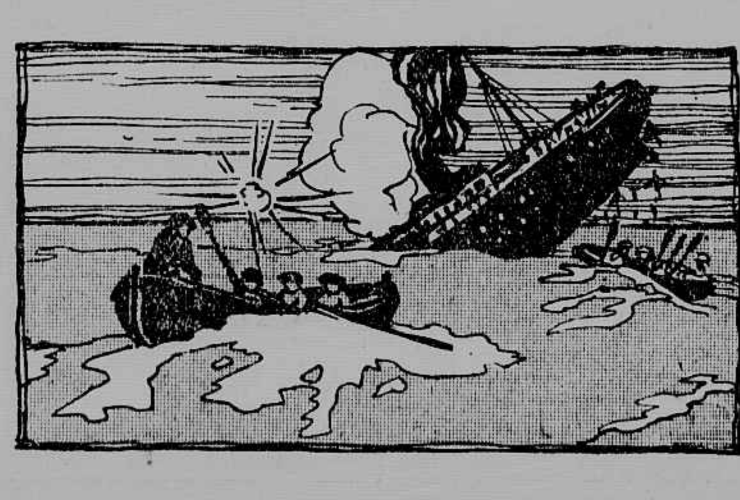
The naval engineer, however, in making plans for ships encounters problems that have never been solved. He can only go ahead and enlarge on this or that design. Such problems enter into the building of concrete ships. As soon as the first one can be launched the rapid construction of others will be a simple matter. The problem lies in getting started. We must find out whether here or there the hull must be thicker or thinner, and this can be determined successfully only when the first ship is in the water.

Personally I am enthusiastic about the possibilities of the future for the concrete vessel. At the present time there is practically little known about the most efficient method of constructing the hulls of ships so that they will resist the many complications of stress.

My reason for feeling so optimistic is based upon what already has been obtained through the evolution of the wooden ship, approximately for the last 4,000 years, and of the iron and steel ship for the past sixty years, combined with the engineering knowledge of the tensile, compressive and diagonal shearing strength of reinforced concrete.

Although the concrete vessel probably will never replace the steel ship, yet for certain services and under certain conditions she may prove more economical and durable.

I believe that the difficulties which will arise as we go ahead with the construction of concrete ships will be solved readily, and without very much delay we will be able to turn them out rapidly. As soon as the first ship is launched hundreds of others can be turned out easily and without draining heavily upon skilled labor that is now practically out of the market. Concrete ships will require a very small number of machinists or skilled craftsmen, as most of the work will be done by unskilled mechanics.



No Reason Known Why Concrete Ship Should Not Succeed

A. G. Monks, of the firm of Monks & Johnson, structural engineers, of Boston, who are consulting engineers for the Liberty Shipbuilding Company and for the Squantum plant of the Fore River Shipbuilding Company, says of the concrete ship:

"From the technical point of view of a structural engineer there is no reason why the concrete ocean-going ship should not be a success. The only reason why one cannot predict success with absolute confidence is that large concrete structures have never been subjected in actual practice to all the strains and stresses and peculiar combinations thereof that a ship must endure."